

We claim:

1. A process for making single-phase lithium-transition metal oxide compounds containing cobalt, manganese and nickel comprising:
 - 5 a) wet milling cobalt-, manganese-, nickel- and lithium-containing oxides or oxide precursors to form a finely-divided slurry containing well-distributed cobalt, manganese, nickel and lithium, and
 - b) heating the slurry to provide a lithium-transition metal oxide compound containing cobalt, manganese and nickel and having a substantially single-
10 phase O3 crystal structure.
2. A process according to claim 1 wherein water is used for wet milling.
3. A process according to claim 1 comprising milling the slurry until it contains particles having an average particle diameter less than about 0.3 μm .
4. A process according to claim 1 comprising milling the slurry until it contains
15 particles having an average particle diameter less than about 0.1 μm .
5. A process according to claim 1 comprising milling the powders using ceramic media.
6. A process according to claim 1 wherein the precursors comprise one or more carbonates.
- 20 7. A process according to claim 6 wherein at least one of the precursors comprises manganese or nickel carbonate.
8. A process according to claim 1 comprising milling together equimolar amounts of manganese- and nickel-containing oxides or oxide precursors.
9. A process according to claim 1 comprising heating the slurry at a rate of at least
25 10° C/min to a temperature of at least 800° C.
10. A process according to claim 1 comprising heating the slurry to a temperature at or below 1050° C.

11. A process according to claim 1 wherein the lithium-transition metal oxide compound is selected from those represented by the formula $\text{Li}_a[\text{Co}_x(\text{Ni}_{1/2} \text{Mn}_{1/2})_{1-x}] \text{O}_2$, where $0 \leq a \leq 1.2$ and $0.1 \leq x \leq 0.98$.
12. A process according to claim 1 wherein the lithium-transition metal oxide compound has the approximate formula $\text{Li}(\text{Co}_{0.8}\text{Mn}_{0.1}\text{Ni}_{0.1})\text{O}_2$.
13. A process according to claim 1 wherein the lithium-transition metal oxide compound has the approximate formula $\text{Li}(\text{Co}_{1/3}\text{Mn}_{1/3}\text{Ni}_{1/3})\text{O}_2$.
14. A process according to claim 1 wherein the lithium-transition metal oxide compound has the approximate formula $\text{Li}(\text{Li}_{0.08}\text{Co}_{0.15}\text{Mn}_{0.375}\text{Ni}_{0.375})\text{O}_2$.
15. A process according to claim 1 further comprising mixing particles of the lithium-transition metal oxide compound with conductive carbon and a binder and coating the resulting mixture onto a supporting substrate to form a lithium-transition metal oxide cathode.
16. A process according to claim 15 further comprising placing the cathode, an electrically compatible anode, a separator and an electrolyte into a container to form a lithium ion battery.
17. A process according to claim 16 wherein the battery capacity does not substantially decrease after the battery is charged and discharged between 4.4 and 2.5 volts for at least 100 cycles at a 75 mA/g discharge rate.
18. Lithium-transition metal oxide compounds having the formula:

$$\text{Li}_a\text{Co}_b\text{Mn}_c\text{Ni}_{1-b-c}\text{O}_2$$
where $0 \leq a \leq 1.2$, $0.52 < b \leq 0.98$, $0.01 \leq c \leq 0.47$ and $0.53 < b+c \leq 0.99$.
19. A lithium-transition metal oxide composition consisting essentially of a compound selected from the group consisting of the single-phase compounds $\text{LiNi}_{0.1}\text{Mn}_{0.1}\text{Co}_{0.8}\text{O}_2$, $\text{Li}(\text{Co}_{1/3}\text{Mn}_{1/3}\text{Ni}_{1/3})\text{O}_2$ and $\text{Li}(\text{Li}_{0.08}\text{Co}_{0.15}\text{Mn}_{0.375}\text{Ni}_{0.375})\text{O}_2$.

20. A lithium ion battery comprising at least one lithium-transition metal oxide compound of claim 18.

21. A lithium ion battery comprising at least one lithium-transition metal oxide composition of claim 19.